EFFECTIVENESS OF OZONE WATER AS AN ALTERNATIVE IRRIGATION SOLUTION BACTERIA IN ROOT CANAL TREATMENT

LITERATURE REVIEW

THESIS

Submitted to complete one of the conditions
Achieving a Bachelor's Degree in Dentistry

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DEPARTMENT OF CONSERVATION
FACULTY OF DENTISTRY
HASANUDDIN UNIVERSITY
MAKASSAR
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APPROVAL SHEET

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PREFACE

بِسْمِ اللهِ الرَّحْمٰنِ الرَّحِيْمِ

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ABSTRACT

EFFECTIVENESS OF OZONE WATER AS AN ALTERNATIVE IRRIGATION SOLUTION BACTERIA IN ROOT CANAL TREATMENT

Alya Tasya Widjaya

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Background: Root canal treatment is a treatment procedure to eliminate infection causing bacteria in the root canal and periapical tissue as well as close the canal that has been thoroughly disinfected. Root canal treatment failures are caused by treatment procedure errors. One of the main causes of treatment failure due to persistent microbiological infection. Some of the bacteria that are widely isolated and found in cases of root canal treatment failure include *Enterococcus faecalis, Staphylococcus aureus* and *Streptococcus viridans.* One of the stages of root canal care that needs to be considered is the irrigation of the root canal.Irrigation solutions can facilitate the removal of necrotic tissue, bacteria, and dentinal debris from infected root canals. Irrigation solutions commonly used in root canal treatment are sodium hypochlorite (NaOCl), Therefore, many studies have been carried out to develop other materials as an alternative to irrigation solutions to obtain optimal disinfection in root canal treatment, one of which is the use of ozone water. Root canal irrigation using ozone water is known to remove bacteria, so it is expected to increase the success of root canal treatment. **Purpose:** To understand the potential of ozone water as an alternative irrigation solutions against *Enterococcus faecalis, Staphylococcus aureus,* and *Streptococcus viridans* bacteria in root canal treatment based on existing research. **Method:**Literature Review. **Result**:Based on several studies that have been done, it can be concluded that ozone water is a strong and effective disinfectant as an antibacterial agent against some of the dominant bacteria in root canals. **Conclusion:** The effectiveness of ozone water as an alternative ingredient for irrigation solutions is not able to beat existing irrigation solutions.

Keywords: *Root canal treatment, Enterococcus faecalis, Staphylococcus aureus, and Streptococcus viridans ,Irrigation Solutio , Ozone Wate*

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CHAPTER 1

INTRODUCTION

1.1 Background

Root canal treatment is a treatment procedure to eliminate infection of bacteria in the pulp and periapical tissue, as well as close the canal that has been thoroughly disinfected.[1,2] Root canal treatment failure occurs due to several factors, including inadequate root canal preparation, obturation non-hermetic roots, and persistent infection in root canals. Some of the bacteria that are widely isolated and found in cases of failure of root canal treatment include *Enterococcus faecalis, Staphylococcus aureus,* and *Streptococcus viridans*. [3,4] *Enterococcus faecalis* (*E. faecalis*) is a bacteria which can colonize and survive in root canals root canal treatment. *Enterococcus faecalis* is more resistant to sodium hypochlorite (NaOCl) than other microorganisms. *Staphylococcus aureus* is a bacteria that has an ability to penetrate the dentinal tubules, so in biomechanical preparations step (cleaning and shaping) are not effective. *Streptococcus viridans* is a bacteria isolated from root canals which bacteria causing subacute bacterial endocarditis in humans, therefore the dentists must should be considerate in the root canal treatment, especially in root canal treatment. One of the important steps in root canal treatment is root canal irrigation.[5,6,7,8]

Irrigation solutions can facilitate the removal of necrotic tissue, bacteria, and dentinal debris from infected root canals. Irrigation solutions commonly used in root canal treatment are sodium hypochlorite (NaOCl), ethylenediaminetetraacetic acid (EDTA), chlorhexidine (CHX), and a mixture

of tetracycline acid and detergent (MTAD). Sodium hypochlorite is widely used because it has an antimicrobial effects against various bacteria. Ruddle (2002) stated 5.25% NaOCl solution was able to dissolve and rinse organic tissue and debris in the root canals. However,the disadvantages of NaOCl has an irritant effect on periapical tissues, is can not to dissolve inorganic materials, and has a pungent odor.[9,10] Therefore, many studies have been carried out to develop other materials as an alternative to irrigation solutions to obtain optimal disinfection in root canal treatment, one of which is the use of ozone water. Root canal irrigation using ozone water is known to remove bacteria, so it is expected to increase the success of root canal treatment.[11]

Ozone is an unstable molecule consisting of 3 atoms that in the body can quickly decompose into oxygen (O2) and singlet oxygen (O1). Singlet oxygen (O1) is very reactive to substances that should not be present in the body, such as bacteria, viruses, fungi, and metabolic waste. The mechanism is that ozone will kill bacteria by oxidizing, destroying microbial cell walls, and damaging nucleic acids, carbon, and nitrogen chains of microbial cell walls. It causes ozone water to act as a strong disinfectant.[12] Ozone is effective against endodontic pathogenic bacteria, making it an alternative to irrigating solutions in root canal treatment.

Based on the description above, the authors conducted a literature review to find out the research that had been conducted on ozone water as an alternative ingredient for irrigation solutions against several bacteria that play a role in root canal treatment.

1.2 Problem Formulation

Based on the background described, the problem is formulated as follows: What is the potential of ozone water as an alternative ingredient for irrigation solutions against some bacteria in root canal treatment?

1.3 Writing Purpose

General Purpose

Understand the potential of ozone water as an alternative ingredient for irrigation solutions against several bacteria in root canal treatment.

Special Purpose

Understand the potential of ozone water as an alternative ingredient for irrigation solutions against *Enterococcus faecalis, Staphylococcus aureus, and Streptococcus viridans* bacteria in root canal treatment based on existing research.

1.4 Benefits Of Writing

Add insight and knowledge about the potential of ozone water as an alternative ingredient for irrigation solutions against bacteria that play a role in root canal treatment.

CHAPTER II

LITERATURE REVIEW

2.1 Root Canal Treatment

Root canal treatment is a treatment that aims to maintain function of tooth in the oral cavity. Root canal treatment consists of several stages: root canal preparation, including cleaning and shaping (biomechanical preparation), disinfection, and root canal obturation. Thus enabling a person to maintain teeth and improve overall function and aesthetics.[13]

Root canal treatment failures are caused, among others, by treatment procedure errors.[14] Factors frequently associated with endodontic failure are bacterial persistence, inadequate root canal filling, improper coronal closure resulting in leakage, and instrumentation complications—one of the leading causes of treatment failure due to persistent microbiological infection. Treatment will have a higher chance of failure if bacteria persist in the root canal during root canal obturation. Bacteria nesting in the root canal area, such as isthmus, dentinal tubules, and branches, can be avoided by disinfectant. According to the Quality Assurance Guidelines issued by the American Association of Endodontics, the criteria for successful root canal treatment are teeth that are not sensitive to percussion and palpation, normal mobility, no sinus tracts, teeth that can function properly, and no signs of infection or swelling. [3]

2.2 Root Canal Irrigation

Irrigation procedure in root canal treatment is the key to root canal treatment which consists of mechanical, chemical, and biological functions.

Because the irrigation step facilitates the removal of necrotic tissue, bacteria, and dentinal debris from the infected root canal. Irrigation is performed to eliminate debridement and ensure root canal cleanliness, which irrigation cannot achieve with instrumentation.[15]

The irrigation stage is carried out by flowing the irrigation solution into the root canals as an effective measure of mechanical cleaning of the root canal walls to remove debris. Next, the irrigation solution will chemically dissolve the remaining organic matter and destroy bacteria. This irrigation solution will clean all debris from the root canal system and eventually release root canal irritants.[17]

2.2.1 Irrigation Solutions

Selection of irrigation solutions requires good knowledge and understanding of the properties of various irrigation solutions. Several types of root canal irrigation solutions that are widely used are sodium hypochlorite solution (NaOCl), chelator/ethylene diamine tetraacetic acid (EDTA) solution, a mixture of tetracycline, acid, and detergent (MTAD), chlorhexidine (CHX).[18]

2.2.1.1 Sodium Hypochlorite (NaOCl)

Sodium hypochlorite is the most frequently used irrigating solution. It is a clear, pale, yellow-green liquid with a strong chlorine odor. Commonly used concentrations are 0.5%, 1%, 2.5%, 3%, and 5.25%. It is a reducing agent and should be stored in the shade. Sodium hypochlorite functions as a debridement, antimicrobial lubricant, and soft tissue solvent.[14]

2.2.1.2 *Ethylene diamine tetraacetic acid* (EDTA)

The chelator solution often used in root canal treatment is the disodium

salt of ethylenediamine tetraacetic acid (EDTA) at a concentration of 17% in a neutral solution. Kelator is a solvent for inorganic components and has a common anti-bacterial effect, so it is recommended as a complement in root canal irrigation after sodium hypochlorite.[11]

2.2.1.3 Mixture of tetracycline an acid and a detergent (MTAD)

The mixture of tetracycline, an acid, and a detergent (MTAD) is a solution that contains a mixture of tetracycline, acid, and detergent. The advantage of MTAD is that it makes the irrigation stages simpler because it combines the ability to remove smears and antimicrobial. The effectiveness of MTAD in removing the smear layer and disinfecting the root canal has been demonstrated in several studies. The combination of 1.3% NaOCl irrigation solution and MTAD as a final rinse is more effective than 5.25% NaOCl solution.[9]

2.2.1.4 Chlorhexidine (CHX)

Chlorhexidine is a potent antiseptic in the form of a solution widely used as a chemical plaque control in the oral cavity, with a recommended concentration of between 0.1% -0.2%. As a root canal irrigation agent, the attention is 0.12% and 2% for root canal sterilization. However, chlorhexidine is not used as the leading irrigating agent because this material cannot dissolve the remaining necrotic tissue and is less effective against Gram-negative bacteria.

2.3 Dominant Bacteria In Root Canal

2.3.1 *Enterococcus faecalis* (*E. faecalis*)

Enterococcus faecalis is a non-spore-fermentative, facultative, Gram-positive cocci bacterium. Enterococcus faecalis cells are round and 0.5 - 1 µm

in diameter. They form singly, in pairs, or short chains and often extend along the chain. Most strains are nonhemolytic and nonmotile. *Enterococcus faecalis* is a bacterium that can survive in very extreme environments, including very alkaline pH and high Gram concentrations.[19]

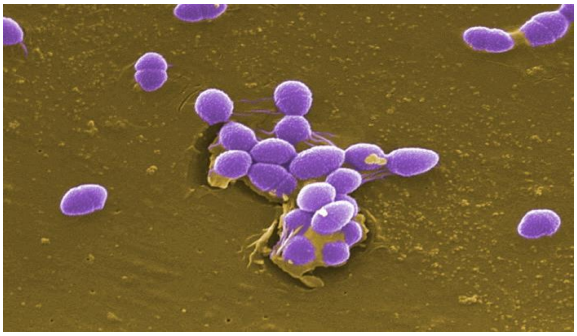

Figure 2.1 *Enterococcus faecalis*. Source: Soliman and Leonard. Medical News. (2022)

Enterococcus faecalis is a bacterium commonly found in root canals and survives even after being treated, making Enterococcus faecalis a pathogenic bacterium that causes root canal treatment failure. The cell wall of *Enterococcus faecalis* bacteria consists of 40% peptidoglycan. The remainder is teichoic acid and polysaccharides. Peptidoglycan synthesis results from a balance between polymerizing and hydrolytic enzymes. Peptidoglycan is the main macromolecule in determining cells' shape and maintenance. This substance is also helpful as a protective layer from damage due to high cytoplasmic osmotic pressure.[21,22]

2.3.2 *Staphylococcus aureus* (*S. aureus*)

Staphylococcus aureus (S. aureus) is a Gram-positive cocci that produce a yellow pigment, is facultatively anaerobic, does not produce spores, and does not move, generally grows in pairs or groups, with a diameter of about 0.8-1.0 µm, arranged in non-small groups. Regular with grape-like formations, found

in single or paired cocci, not encapsulated and on agar media indicated by the appearance of golden yellow colonies.

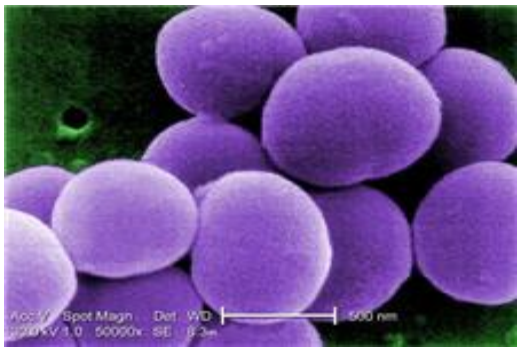

Figure 2.2 *Staphylococcus aureus.* Source: CDC. Healthcare-Associated Infection (2011) [23]

This bacterium grows optimally at 37C with a division time of 0.47 hours. *Staphylococcus aureus* is a human microflora in the oral cavity. It can cause acute dentoalveolar infections, jaw cysts, endodontic abscesses, parotitis, oral mucosal lesions, and stomatitis.[24]

2.3.3 *Streptococcus viridans* (*S. viridans*)

Streptococcus viridans is a large group of Gram-positive bacterial species that are hemolytic, producing a green color on blood agar plates. However, some species of this group are hemolytic, meaning they do not change blood agar

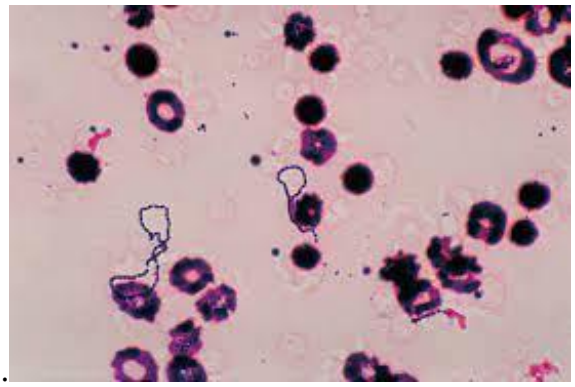

Figure 2.3 *Streptococcus viridans.* Source: CDC. Healthcare-Associated Infection (2011) [23]

One of the most frequently identified anaerobic bacteria in infected root canals is Streptococcus viridans. This bacterium causes subacute bacterial

endocarditis in humans, so dentists must be careful in performing dental care, especially root canal treatment.[25]

2.4 Ozone

The word ozone comes from Greek, meaning smell, and was first used by the German chemist Christian Friedrich Schonbeinhein in 1840. The composition level of ozone was using a mixture of 0.05% - 5% O3 and 95% - 99.95% O2. Therefore ozone has a degree of instability of the O3 molecule. In its use in the medical field, ozone takes less than one hour, so ozone cannot be used for long periods.[26]

2.4.1 Definition and General Properties oOf Ozone

Ozone is a gaseous element in the air consisting of 3 oxygen atoms. Ozone exposed to ultraviolet radiation will decompose into singlet oxygen (O1) and oxygen (O2). Singlet oxygen (O1) is very reactive, especially for substances that should not be present in the body, such as bacteria, viruses, fungi, and other parasites. Ozone is an unstable molecule consisting of 3 atoms which is a very strong oxidant, colorless gas, and has a characteristic odor. Singlet oxygen produced from ozone decomposition is highly reactive and oxidizes organic matter. Its oxidation capacity is more significant than chlorine, so it effectively kills bacteria.[26]

The nature of ozone can oxidize and decompose harmful substances and is effective in sterilization because it eradicates odor-decomposing bacteria quickly and effectively. Ozone effectively kills bacteria because of its ability to destroy bacterial cell walls to inhibit bacterial activity. Therefore, ozone is

widely used as a medium for sterilization and is safe in the health sector because it does not cause side effects.[12]

2.4.2 Ozone For Root Canal Irrigation

The use of ozonized water in dentistry is known to have a strong oxidizing effect. Currently being discussed as an alternative antiseptic with a high antimicrobial impact without drug resistance. It can be used as an irrigation of infected root canals used as an antimicrobial agent.[11]

2.4.3 Mechanism Of Ozone Water

Ozone kills bacteria by oxidizing and destroying cell walls to kill and destroy resistant cell walls and bacteria, such as bacterial spores, to viruses in low concentrations and in a short time. The ozone disinfection mechanism is directly oxidizing or damaging the cell walls and breaking the main bonds of carbon and nitrogen. So, after being oxidized, it results in damage to the cell wall. Oxidation causes ozone to enter quickly and damage the cell wall and cytoplasmic membrane of bacteria. This shows that bactericidal ozonated water can be used as a disinfectant.[22]